

Contribution Toward an Understanding of *Polystichum aleuticum* C. Chr. on Adak Island, Alaska

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Polystichum aleuticum has been described as one of the most restricted and rare ferns in North America (Smith 1985). The species was first collected in 1932 on Atka Island, Aleutian Islands, Alaska, by W. J. Eyerdam (an assistant to E. Hultén), and described by Christensen (1938). Recent attempts to relocate the original collection site on Atka Island have been unsuccessful (Smith & Davison, 1988). It was not rediscovered until a new population was found in 1975 on the northeast arm of Mt. Reed, Adak Island (Smith, 1985). Several subsequent searches in the Aleutian Islands led by R. Lipkin (Adak, Kagalaska Island), D. K. Smith (Adak, Atka Island), S. S. Talbot (Adak, Attu Island), and G. Tande (Adak Island) failed to locate new populations (Anderson, 1992). Finally, in 1988, S. L. Talbot and S. S. Talbot identified a second Adak Island locality on Mt. Reed, several hundred meters north of the first. These two populations formed the basis of a detailed study designed to characterize the habitat and establish permanent monitoring plots (Tande, 1989). Because *Polystichum aleuticum* is an endangered species (U.S. Department of Interior, 1988), field surveys were initiated in September 1993 to locate new populations. Thirteen major areas were selected for searches on Adak Island in September 1993 (S.L.T., S.S.T.) and twelve in August 1994 (W.B.S., S.L.T., S.S.T.). These extended from Mt. Adagdak in the north to the Lake Joan area in the south, a distance of 28 km, and from Three Arm Bay in the west to Kagalaska Strait in the east, a distance of 30 km. Sites include a wide range of geographic variation with habitats strongly matching those of known locations.

While exploring a rock outcrop on the northwest arm of Mt. Reed in 1993, Sandra Talbot discovered a third locality of *Polystichum aleuticum* located at 51°49.960'N, 176°44.141'W at an elevation of 360.4 m asl. Like previous localities, the site was at the base of a steep rock outcrop on a northeast-facing upper slope below the summit. Notably, the third site was 2.8 km from previously known sites and approximately 120 m lower in elevation, thus expanding the geographical and elevational range of *P. aleuticum*. The other two sites were on the northeast arm of Mt. Reed and separated from each other by only 370 m. A total of five clumps constituted the new population, four associated with rock grottos and one clump located close to the grotto in a herb meadow. One clump in the grotto contained four fronds about 10 cm in height, and lacked sori; a second clump contained five fronds 10 cm in height, also

without sori; a third contained ten fronds about 10–15 cm, with sori plus a few dead fronds of the previous year; the fourth clump contained three fronds, all with sori. The meadow clump contained eight fronds about 10–15 cm in height. The presence of sori on some *P. aleuticum* fronds suggested that this population could be useful if spores were used for controlled propagation. Furthermore, because the third site is geographically isolated from the other two sites, the plants at the third site might be genetically distinct from plants at the first two sites. If so, progeny from these plants might benefit a propagation program.

Vascular plant associates of this new *P. aleuticum* population were the creeping dwarf shrubs, *Cassiope lycopodioides*, *Salix arctica*, and *S. rotundifolia*; forbs, *Achillea borealis*, *Anemone narcissiflora*, *Angelica lucida*, *Arnica unalaschensis*, *Campanula* cf. *lasiocarpa*, *Conioselinum chinense*, *Cystopteris fragilis*, *Geum rossii*, *Lupinus nootkatensis*, *Lycopodium selago*, *Oxyria digyna*, *Ranunculus occidentalis*, *Saxifraga unalaschensis*, *Veronica stelleri*, *Viola langsдорffii*; and graminoids, *Carex macrochaeta*, *Poa hispidula* var. *viviparum*, and *Tofieldia coccinea*. Comparison of this species list to the lists of Tande (1989) from the northeast arm populations indicates a high degree of similarity in species composition among the three known populations.

We recorded precise geographic coordinates for the northern and southern sites on the northeast arm of Mt. Reed using a portable hand-held Global Positioning System (GPS) as 51°49.640'N, 176°41.861'W and 51°49.491'N, 176°41.776'W, respectively. These coordinates correct the location reported as 51°49'N, 176°44'W (Smith, 1985) for the southern site and establish the location for the northern site.

Our observations comparing the three sites led us to hypothesize that airborne spores of *P. aleuticum* may first produce gametophytes in rock grottos or moist crevices, and that sporophytes become established in time. These steep sites are being eroded through natural processes. We observed two plants that were precariously clinging by a few, thin roots. As erosion occurs, some plants appear to be transported downhill. Some may re-establish in meadows several meters below their original site. Attempts to locate populations at greater distances from rock outcrops were unsuccessful. This suggests that *P. aleuticum*: (1) originally establishes in the grottos, or (2) is sometimes displaced through erosion, or (3) re-establishes for a period in the meadows, or (4) is eventually either out-competed in the meadows or unable to thrive in a habitat which may become increasingly unfavorable with increasing distance from the grotto.

To further define and characterize the microhabitats associated with *P. aleuticum*, a list of the bryophytes was prepared for each site (Table 1). The bryophytes associated with *P. aleuticum* are not narrowly restricted to these three sites, rather they occur more generally in steep, protected moist outcrops.

We also collected four soil samples (top 10 cm) from *P. aleuticum* sites on the northeast arm of Mt. Reed to record soil chemical characteristics. No unusual values were noted; values were within the normal range for the Aleutian Islands (Rieger et al., 1979). Mean values with range in parentheses were as

TABLE 1. List of bryophytes associated *Polystichum aleuticum* sites on Mt. Reed, Adak Island, Alaska. Bryophytes determined by W.B.S. Site 1 is the northeast arm of Mt. Reed, north site; Site 2 is the northeast arm of Mt. Reed, south site; Site 3 is the northwest arm of Mt. Reed. Bryophytes designated by an asterisk are present at all three sites. Microhabitat legend: Ba = base; Cl = cliff; Cd = damp cliff; Cr = crevice, T = turf; Tl = turf in ledge; Ts = turf on shelf, Tb = Turf at base; Lg = ledge; Sf = shelf; — = not observed. Vouchers preserved at University of British Columbia (UBC).

Species	Site		
	1	2	3
Mosses			
<i>Amphidium lapponicum</i> *	Cr	Cr	Cr
<i>Andreaea alpestris</i>	Cl	Cl	—
<i>Anoetangium aestivum</i>	—	Cr	Cr
<i>Aulacomnium turgidum</i>	Tb	Ts	—
<i>Blindia acuta</i> *	Cl	Cl	Cr
<i>Brachythecium plumosum</i>	Cl	Cl	—
<i>Bryhnia hultenii</i>	Ba	—	Ba
<i>Bryoerythrophyllum ferruginascens</i> *	Cr	Cr	Cr
<i>Bryoxiphium norvegicum</i> *	Cr	Cr	Cl
<i>Bryum</i> sp. (sterile)	Cr	—	—
<i>Campylium stellatum</i>	Ba	—	Ba
<i>Ctenidium schofieldii</i>	Ts, Ba	—	—
<i>Dicranum majus</i>	—	Ts, Ba	—
<i>Distichium capillaceum</i> *	Ts	Cr	Cr
<i>Distichium crispatisimum</i>	—	—	Ts
<i>Grimmia torquata</i>	Cr	Cr	—
<i>Gymnostomum aeruginosum</i>	—	Cr	Cr
<i>Hylocomiastrum pyrenaicum</i> *	Ba	Ts, Ba	Ba
<i>Hylocomium splendens</i> *	Ba	Ts, Ba	Ba
<i>Hypnum lindbergii</i>	Ba	—	Ba
<i>Hypnum plicatulum</i> *	Ts	Ts	Ts
<i>Isopterygiopsis pulchella</i>	Cr	—	Cr
<i>Kiaeria falcata</i>	Cl	—	—
<i>Mnium marginatum</i>	—	Cr	Ts
<i>Myurella julacea</i> *	Cr	Cr	Cr
<i>Orthothecium cryseum</i> *	Cr	Cr	Sf
<i>Orthothecium strictum</i>	—	Cr	Sf
<i>Paraleucobryum enerve</i>	—	Ts, Ba	—
<i>Philonotis fontana</i>	Ts	—	—
<i>Plagiobryum zierii</i>	—	Cr	—
<i>Plagiothecium cavifolium</i>	Cr	—	—
<i>Pleuroziopsis ruthenica</i>	—	—	Ba
<i>Pleurozium schreberi</i>	Ba	Ts, Ba	—
<i>Pogonatum urnigerum</i>	Tb, Cr	—	—
<i>Polytrichastrum alpinum</i>	—	—	T
<i>Polytrichum strictum</i>	Tb	—	—
<i>Pseudoleskea baileyi</i>	—	Ba	—
<i>Racomitrium elongatum</i>	Tb	—	—
<i>Racomitrium fasciculare</i>	Cl	—	—

TABLE 1. Continued.

Species	Site		
	1	2	3
<i>Racomitrium lanuginosum</i> *	Ts	Ts	Sf
<i>Racomitrium sudeticum</i>	—	Cr	—
<i>Rhytidiadelphus loreus</i> *	Ba	Ba	Ba
<i>Rhytidiadelphus squarrosus</i> *	Ba	Ba	Ba
<i>Rhytidiadelphus triquetrus</i> *	Ba	Ba	Ba
<i>Sanionia orthothecoides</i> *	Ba	Ba	Ba
<i>Schistidium apocarpum</i>	Cl	—	—
<i>Sphagnum warnstorffii</i>	Ts, Ba	Ts	—
<i>Thuidium philibertii</i> *	Ba	Ba	Ba
<i>Timmia austriaca</i>	Ts	—	Cr
<i>Tortella tortuosa</i>	Cr	Cr	—
<i>Trachycystis flagellaris</i> *	Cr	Cr	Ba
Liverworts			
<i>Aneura pinguis</i> *	Cr	Cr	Ts
<i>Anthelia julacea</i>	—	Cr	Ts
<i>Bazzania tricrenata</i>	—	Ts	Ts
<i>Blepharostoma trichophyllum</i>	Cr	—	Cr
<i>Diplophyllum albicans</i>	Cr	—	Ts
<i>Diplophyllum imbricatum</i>	Ts	—	—
<i>Diplopohyllum plicatum</i> *	Ts	Ts	Ts
<i>Frullania nisquallensis</i>	—	—	Sf
<i>Herbertus aduncus</i> *	Ts	Ts	Ts
<i>Herbertus sakuraii</i>	Ts	—	—
<i>Lophozia barbata</i>	—	Cr	—
<i>Marsupella</i> sp.	Cd	Cl	—
<i>Plagiochila poeltii</i> *	Ts	Ts	Ts
<i>Plagiochila schofieldiana</i>	Ts, Ba	—	—
<i>Plagiochila semidecurrens</i>	Ts, Ba	Ts	—
<i>Preissia quadrata</i>	Cr	—	Cr
<i>Ptilidium ciliare</i>	Ts, Ba	—	—
<i>Radula polyclada</i>	Cr	Cr	—
<i>Radula prolifera</i>	—	—	Ts
<i>Scapania ornithopodioides</i> *	Tb	Tb	Tb

follows: pH 5.85 (5.47–6.20), electrical conductivity 0.21 mho (0.13–0.34), phosphorous <1 ppm (<1), potassium 85 ppm (32–137), calcium 1,581 ppm (478–3,949), magnesium 309 ppm (143–570), sodium 17.9 ppm (15.8–20.3), copper 10.0 ppm (6.0–12.1), zinc 0.8 ppm (0.2–1.2), manganese 11.7 ppm (7.2–14.3), iron 214 ppm (99–276), boron 0.85 ppm (0.24–1.84), total nitrogen 0.60% (0.42–0.81), total carbon 7.98% (5.37–10.68), and total sulphur 0.10% (0.06–0.13).

In a recent update of his fern manual, Lellinger (1985) contended that *P. aleuticum* was conspecific with *P. lachenense* of Asia, although no quantitative evidence was cited to justify this reclassification. If *P. aleuticum* is of Asian origin, it is possible that other spore-bearing Asiatic species might be associated with it, transported by the same vector, and occupying a comparable hab-

itat. Although no such pattern occurs in the vascular flora of Adak, a similar phytogeographic pattern might be paralleled by bryophytes, as they are often restricted to microhabitats. Most of the bryophytes associated with the three fern populations were not specifically Asian, nor were there any narrow endemics. However, notably one Himalayan hepatic, *Plagiochila poeltii*, recently reported as new to North America (Davison & Smith, 1994) is closely associated with *P. aleuticum* and known only from Adak and Atka Islands. Thus, the phytogeographic pattern of *Plagiochila poeltii* is coincident with *Polystichum aleuticum* in North America. In the westernmost Aleutians, there are a number of Asiatic vascular plants found no further east than Attu and Alaid Islands (Hultén 1960), and an Asian moss (Schofield & Talbot, 1991) recently reported from Attu Island is also on Adak Island. These localities represent its full North American range. Davison (1993), in his unpublished Ph.D. thesis, has also noted several Asiatic hepatics on Attu Island. One Asian fern species, *Polystichum microchlamys* (H. Christ) Matsumura, occurs no further east than Attu Island (Wagner, 1993).

Placing *P. aleuticum* into synonymy with *P. lachenense* has significant ramifications when viewed in light of the Endangered Species Act of 1973, as amended through the 100th Congress, which protects species and subspecies of plants but not plant populations. In contrast to plants, the Act permits listing distinct vertebrate populations. Thus, although the intent of Congress may be to protect U.S. plant populations, they are not specifically protected by the Act. We therefore suggest detailed morphological comparisons between *P. aleuticum* and *P. lachenense* be performed coupled with molecular phylogenetic techniques in order to determine the Aleutian shield-fern's phylogenetic affinities. This may prove somewhat difficult, in view of the need to protect *P. aleuticum* from collection, thus creating a scarcity of material for study. Based on what is available, however, such research could be accomplished.

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